pressure 29.38, in 33° N., 160° E., on the 22d, while vessels in the Aleutian region toward the center of the great winter LOW experienced pressures much lower than 29 inches, with only moderate winds. The lowest pressure recorded in these waters by a vessel this month was 28.46 inches, read on board the Japanese S. S. *Ibukisan Maru*, in 47° 45′ N., 165° 20′ W., on the 29th, highest wind force 9 SW. Of course steepness of pressure gradient in large measure determined the relative strength of these winds.

NOTE

American S. S. *Pacific*, Puget Sound southward.—December 6, latitude 47° 10′ N., longitude 124° 33′ W. Sighted moderate waterspout about 2 miles to westward.

ONE TYPHOON OVER THE PHILIPPINES IN DECEMBER, 1924

By REV. JOSÉ CORONAS, S. J.

[Weather Bureau, Manila, P. I.]

There has been only one really well-developed typhoon in the Far East during this month of December; and this is the one that traversed the central part of the Philippines on the 19th and 20th and influenced the weather in most of our southern stations for eight or more successive days. Heavy, prolonged rains with destructive floods have been reported, particularly from places in Surigao, Cebu, Samar, and Leyte provinces. Great landslides have been also reported as an effect of heavy continuous rains in the Province of Surigao. Our observer at Surigao has reported the following daily amounts of rain in that place for the period of December 11 to 15, the heavy rains having begun even two days before the typhoon was noticed to the east of Surigao: December 11, 190.6 millimeters (7.50 inches); December 12, 183.5 millimeters (7.23 inches); December 13, 223.1 millimeters (8.78 inches); December 14, 328.9 millimeters (12.95 inches); December 15, 93.9 millimeters (3.70 inches); total in five days, 1,020 millimeters (40.16 inches).

The typhoon was first shown by our weather maps on December 13, between Yap and Mindanao, not far from 133° longitude E., between 9° and 10° latitude N. It moved probably west by north until the 15th, when it inclined northward near to the east of Surigao Strait. Then it remained almost stationary, or continued moving very slowly in the 16th, 17th, and part of the 18th, until finally in the afternoon of the 18th it inclined decidedly to the west.

On the 19th warnings were sent to the effect that the typhoon was moving practically west from the Strait of San Bernardino, threatening Romblon and Mindoro. In fact, the center passed over San Bernardino Strait, where the vortical calm was observed on board the steamer *Ulises* (barometric minimum 742 millimeters, 29.21 inches, shortly after noon of December 19; and over Romblon, where absolute calm was also reported by our observer at 8 a. m of December 20. The rate of progress of the typhoon was of about only 6 to 7 miles per hour on the 19th and 20th.

In the China Sea the typhoon continued moving west until the afternoon of the 21st, when it inclined to west-northwest. In the afternoon of the 22d the center was situated in about 115° longitude E and 14° latitude N., where it has at this writing (December 25) remained almost stationary for about two days, probably filling up gradually.

The position of the center at 2 p. m. of December 19, 20, and 21, and 6 a. m of December 20, 21, and 22, was as follows:

December 19, 2 p. m., 124° 10′ longitude E., 12° 40′ latitude N.

December 20, 6 a. m., 122° 25′ longitude E., 12° 40′ latitude N.

December 20, 2 p. m., 121° 35′ longitude E., 12° 40′ latitude N.

December 21, 6 a. m., 119° 05′ longitude E., 12° 45′. latitude N.

December 21, 2 p. m., 117° 25′ longitude E., 12° 50′ latitude N.

December 22, 6 a. m., 116° 10′ longitude E., 13° 15′ latitude N.

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DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

ALFRED J. HENRY

Practically a normal month up to the 18th when a southward flow of cold air from high latitudes set in, culminating on the 21st in extraordinarily high pressure over the Rocky Mountain and Plateau regions. The effect of the high pressure and associated low temperature was felt until about the end of the month. The usual details follow:

CYCLONES AND ANTICYCLONES

By W. P. DAY

The barometric pressure was abnormally high over Alaska from the 12th until the 28th, reaching its first great maximum on the 14th at Eagle. Meanwhile, this condition spread southeastward and reached Alberta on the 15th and carried as far as the lower Missouri Valley. With one or two interruptions the Alaska HIGH spread slowly southeastward until by the 21st there was one area of continuously high pressure extending from the northwestern limits of Alaska to the Atlantic coast. The southeastward movement of this great mass of cold air had been retarded by the persistance of high pressure extending westward from Bermuda, but it finally prevailed. Following the breaking down of the area over the United States on the 23d, three more important HIGHS from the parent HIGH in Alaska appeared in the northwest before the close of the month. The large area covered by the individual HIGHS prevented their being so numerous as in the preceding month.

The low-pressure areas after the 15th followed the southern circuit, or appeared first in northern Manitoba. They were less numerous than in November.

FREE-AIR SUMMARY

By V. E. JAKL

It will be noted from Table 1 that there was a pronounced deficiency in temperature at all aerological stations, except Due West, where about normal temperatures prevailed. The departures in the levels near the ground are in agreement with Chart 111, which shows that the greatest fall in temperature below the normal occurred over the Northwestern States. A closer inspection of Table 1 shows that the negative departures diminished in magnitude with increasing altitude, except that

at some stations there was first an increase in the amount of negative departure with altitude up to about 750 meters. As the departures were due mostly to the cold weather in the latter half of the month, beginning with the cold wave that swept over the country from the 15th to 21st, it is of interest to examine some of the upper-air records made during the prevalence of the cold wave, in order to account for the observed gradation of negative departures with altitude. The records at Ellendale for the 16th, 18th, 19th, and 20th, showing upper-air temperatures and winds, and surface pressures, are reproduced in the following table to illustrate the development of the cold wave, first in the lower levels, and later in the higher levels as the HIGH was reinforced. On the 20th, when the HIGH had about reached its crest stage over Ellendale, low temperatures extended from the ground to 4,800 meters, with a change to warmer, as compared with the previous three days, recorded in intermediate altitudes. The records of some of the other aerological stations, notably Drexel, show substantially the same sequence of conditions attending the passage of the cold wave.

Altitude, M. S. L. (meters)	16th			18th			19th			20th		
	Pressure, mb.	Temperature, °C.	Wind direction	Pressure, mb.	Temperature, °C.	Wind direction	Pressure, mb.	Temperature, °C.	Wind direction	Pressure, mb.	Temperature, °C.	Wind direction
444 (surface).	976.2	−24.9	n.	980.4	−29.6	wnw.	980.9	−27.5	wnw.	988.3	−30.5	sw.
750	-----	−28.2	n.	-----	−30.0	wnw.	-----	−23.9	nw.	-----	−21.2	wnw.
1,000	-----	−29.1	n.	-----	−27.9	wnw.	-----	−22.5	nw.	-----	−21.2	nw.
1,250	-----	−29.8	nne.	-----	−28.0	wnw.	-----	−23.3	nw.	-----	−20.4	wnw.
1,500	-----	−28.5	nne.	-----	−27.4	wnw.	-----	−24.2	nw.	-----	−20.8	wnw.
2,500	-----	−12.7	nw.	-----	−19.0	wnw.	-----	−27.8	nw.	-----	−25.3	wnw.
2,800	-----	− 3.8	w.	-----	-----	-----	-----	−29.1	nw.	-----	−26.7	wnw.
3,000	-----	-----	-----	-----	-----	-----	-----	−29.9	nw.	-----	−26.7	wnw.
4,800	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	−35.4	wnw.

This characteristic of the cold wave, connoting as it does a wedge-like front, suggests an explanation of the broad band of precipitation in the form of rain, sleet, and snow that progressed south and southeastward on its front from the 17th to 20th. This was particularly evident in the lower latitudes where great contrasts in temperature and humidity occurred. At Broken Arrow the aerological records show a fall in temperature from the 16th to 19th in the column of air extending up to 2,000 meters, ranging from the highest of record for any December, on the 16th, to a similarly lowest of record on the 19th. At this station heavy precipitation occurred on the 17th and 18th, and while no flights were possible on these dates there appears to be satisfactory evidence that the surface condition of northerly winds and falling temperature was surmounted by winds aloft having south component. The aerological observation on the 19th, extending to 1,600 meters in northerly winds, shows a marked inversion of temperature and falling off in wind velocity at the highest level, indicating the likelihood of a reversal of wind direction at a still higher altitude. In addition, the aerological and cloud observations on the 18th at Groesbeck, 300 miles to the south, show south component winds to high altitudes.

Wind resultants from both kite and pilot-balloon observations covering all portions of the country east of the Rocky Mountains, showed the general trend ro the west, normal for the month. In the upper levels the winds were about due west, while in the lower levels, there was a south component, except over the northern Plains States, where the lower altitude winds had a pronounced northerly component. At Drexel and Ellendale in fact, the northerly tendency of the winds persisted, although with diminishing degree, to the highest levels observed.

Resultant velocities for all stations were decidedly above normal throughout the vertical range of observations, except near the ground. (See Table 2.) A rapid increase in velocity with altitude was characteristic of the month at most stations; consequently the resultant upper-air velocities were generally above normal, particularly in the highest altitudes for which reliable averages were obtained. An examination of the individual records and comparison of them with weather maps at corresponding times, showed that the high velocities aloft so frequently observed were correlated with the general pressure distribution over the country, rather than with the surface pressure gradients at the particular places of observations. As an example chosen from a number of instances of this apparently anomalous relation, the two-theodolite pilot-balloon observation at Broken Arrow on the 10th is cited. This was made in the crest of a high-pressure area, and as might be expected from the absence of perceptible pressure gradient, a state of virtual calm—in this case extending to about 1,000 meters—existed in the lower levels. Above 1,000 meters there was a steady increase in velocity to 23 meters per second from the west at 5,000 meters. Vigorous LOWS to the north and northeast of Broken Arrow and strong winds aloft from a general westerly direction at most aerological stations on this date, indicated a pronounced north-south pressure gradient in the higher altitudes over a considerable portion of the country, irrespective of surface pressure conditions. A relation is therefore suggested between the observed frequency and widespread occurrence of strong upper-air winds and the general vigor in development and movement of HIGHS and LOWS that was a feature of the month.

Among the observations made under the influence of strong surface pressure gradients, two examples are cited, representing the widely divergent wind effects, as regards change in velocity with altitude, associated with well defined LOWS and HIGHS. The first is an observation made at Ellendale on the 22d in the south portion of a vigorous LOW, in which the velocity rose from 16 meters per second on the ground to 28 meters per second at 1,500 meters. The other example is given in the record of the pilot balloon observation at Groesbeck on the 19th, where in the front of the cold wave HIGH previously referred to, wind velocity fell off from 16 meters per second on the ground to 6 meters per second at 1,900 meters. The explanation is to be found in the very steep horizontal temperature gradients, indicating a rapid readjustment of pressure gradient with altitude, and a probable reversal of direction of pressure gradient at some upper level. The record of cloud direction on this date supports the inference of a south component wind above the upper limit of pilot balloon observation.

An aerological record giving undeniable evidence of recurving of colder air from the rear to the front of a LOW is furnished by the kite observations at Broken

Arrow on the 3d and 4th.[1] The position of the LOW with reference to Broken Arrow changed from a point a considerable distance west of Broken Arrow on the 3d, to a short distance north of that station on the 4th. The change to colder in the southerly winds over Broken Arrow is apparent in the comparative temperatures of the 3d and 4th, but is more directly evident in the falling temperature in the levels up to 1,500 meters recorded during the progress of the flight on the 4th. The following table is an abstract of the observations on these dates:

Altitude, M. S. L. (meters)	3d		4th					
	Temperature, ° C.	Wind direction	Time, a. m.	Temperature, ° C.	Wind direction	Time, a. m.	Temperature, ° C.	Wind direction
233 (surface)	8.2	SSE	8.14	9.2	S	10.59	7.2	SW.
500	8.8	S	8.18	7.8	S	10.56	4.8	SSW.
1,000	11.7	SSW	8.28	4.3	S	10.43	1.0	S.
1,500	8.1	SSW	8.39	1.6	SSW	10.30	−1.4	S.
2,000	4.4	SW	8.47	3.1	SSW	10.02	4.6	SSE
3,000			9.20	−3.0	SSW			

A kite flight to an exceptionally high altitude, reaching 6,855 meters above ground (6,996 M. S. L.) was made at Groesbeck on the 11th, in front of a moderate HIGH. This exceeded all previous records for altitude above ground made in this country, although higher altitudes above sea level had previously been reached here and elsewhere. The temperature record of this flight shows a practically isothermal state to 1,500 meters, and an almost uninterrupted decrease at a uniform lapse rate thereafter to the top. Winds backed gradually from northwest on the ground to west in the upper levels.

The principal instance of deep easterly winds over continental regions occurred over Ellendale on the 4th, when winds varying from east-southeast to north-northeast prevailed to 5,000 meters. On this date Ellendale lay in the western limb of an extensive high pressure area with its axis east-west over the middle Northern States and adjoining Canadian Provinces.

[1] An alternative interpretation of the evidence of the kite flights at Broken Arrow is offered, as follows: The fall in temperature from the 3d to the 4th may have been and probably was due to mixing of the lower air strata, as pointed out by Shaw (Meteorology Part IV, pp. 34–35). This mixing would tend to produce an adiabatic temperature distribution with an inversion above and this is precisely what happened on the 4th.—ED.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during December, 1924*

TEMPERATURES (° C.)

Altitude m. s. l. (m.)	Broken Arrow, Okla. (233m.)		Drexel, Nebr. (396m.)		Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)		Groesbeck, Tex. (141m.)		Royal Center, Ind. (225m.)	
	Mean	Departure from 7-yr. mean	Mean	Departure from 10-yr. mean	Mean	Departure from 4-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 7-yr. mean
Surface	2.0	−3.1	−9.5	−5.2	9.2	−0.1	−14.2	−5.6	8.5	−1.6	−4.2	−3.5
250	1.9	−3.1			9.2	0.0			8.0	−1.9	−4.4	−3.0
500	1.7	−2.7	−9.6	−5.4	9.7	+0.8	−14.3	−5.8	6.7	−2.7	−6.4	−4.1
750	1.7	−2.6	−9.8	−6.1	9.7	+1.1	−14.1	−6.5	6.7	−2.5	−6.8	−4.0
1,000	2.7	−2.2	−8.7	−5.9	9.2	+1.0	−12.9	−6.3	8.0	−1.2	−6.5	−3.0
1,250	3.1	−2.0	−8.0	−5.7	8.5	+0.9	−12.4	−6.3	7.9	−0.9	−6.5	−3.6
1,500	3.2	−1.6	−7.6	−5.1	7.6	+0.9	−12.2	−6.0	7.5	−0.7	−6.3	−3.2
2,000	2.4	−1.0	−7.8	−3.9	5.7	+0.7	−12.2	−4.9	6.0	−0.6	−7.8	−3.3
2,500	0.0	−1.2	−9.7	−3.5	3.4	+0.3	−13.0	−3.6	3.5	−1.0	−8.6	−2.3
3,000	−2.2	−0.9	−11.2	−2.6	1.7	+0.8	−15.2	−2.8	1.0	−1.1	−10.3	−1.7
3,500	−4.4	−0.6	−13.3	−2.2	−1.4	0.0	−17.2	−2.0	0.8	+1.3	−13.1	−1.7
4,000	−6.5	0.0	−15.9	−2.1	−4.2	+0.3	−20.1	−2.0	−1.8	+1.4	−16.0	−1.4
4,500	−8.7	+0.6	−18.6	−1.9	−6.8	+0.7	−22.4	−1.9	−3.2	+2.2		
5,000			−21.0	−1.7					−6.5	+1.6		

RELATIVE HUMIDITY (%)

Surface	70	−1	79	+1	72	−2	80	−1	73	−2	81	+1
250	70	−1			71	−2			72	−1	81	+1
500	66	+1	77	+3	63	−5	80	+1	73	+4	80	+4
750	64	+4	73	+6	60	−5	77	+5	67	+3	78	+7
1,000	60	+7	69	+8	58	−5	72	+6	55	−2	71	+6
1,250	54	+7	68	+11	53	−8	68	+7	50	−2	65	+6
1,500	49	+6	67	+12	54	−5	66	+8	46	−2	63	+8
2,000	43	+5	66	+14	52	−3	63	+8	44	+4	64	+12
2,500	42	+5	69	+16	51	+1	62	+7	46	+10	66	+14
3,000	42	+4	70	+17	43	−2	58	+3	40	+7	65	+13
3,500	40	+2	71	+18	50	+4	52	−3	11	−19	58	+4
4,000	35	−2	68	+15	47	0	52	−2	6	−23	52	−2
4,500	35	−2	67	+13	41	−4	52	+3	1	−27		
5,000			66	+12					1	−27		

VAPOR PRESSURE (*mb.*)

Surface	5.84	−0.86	2.68	−1.02	9.41	+0.01	1.95	−0.89	9.99	−0.13	4.08	−0.69
250	5.80	−0.84			9.38	+0.08			9.58	−0.19	4.01	−0.15
500	5.56	−0.31	2.58	−0.95	8.96	+0.40	1.91	−0.89	8.84	−0.10	3.46	−0.12
750	5.35	+0.06	2.37	−0.90	8.22	+0.24	1.79	−0.85	7.97	−0.16	3.24	+0.07
1,000	5.21	+0.51	2.38	−0.71	7.48	+0.12	1.79	−0.71	6.95	−0.21	2.91	+0.10
1,250	4.62	+0.46	2.44	−0.50	6.86	+0.09	1.74	−0.64	6.00	−0.30	2.56	+0.09
1,500	4.24	+0.51	2.42	−0.34	6.24	+0.08	1.69	−0.53	5.15	−0.30	2.46	+0.24
2,000	3.46	+0.46	2.38	+0.02	5.06	+0.05	1.55	−0.33	4.19	+0.23	2.31	+0.53
2,500	2.86	+0.37	2.17	+0.13	4.30	+0.30	1.43	−0.16	3.37	+0.38	2.28	+0.83
3,000	2.32	+0.18	1.97	+0.25	3.15	−0.06	1.23	−0.05	2.10	−0.22	2.05	+0.90
3,500	1.89	+0.06	1.74	+0.31	2.69	−0.14	1.01	+0.01	0.21	−1.48	1.35	+0.42
4,000	1.46	−0.10	1.51	+0.37	1.61	−0.59	0.85	+0.03	0.01	−1.36	0.86	+0.25
4,500	1.18	−0.20	1.45	+0.57	0.61	−0.90	0.81	+0.21	0.01	−1.12		
5,000			1.38	+0.70					0.01	−0.94		

TABLE 2.—*Free-air resultant winds (m. p. s.) during December, 1924*

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233 m.)				Drexel, Nebr. (396 m.)				Due West, S. C. (217 m.)				Ellendale, N. Dak. (444 m.)				Groesbeck, Tex. (141 m.)				Royal Center, Ind. (225 m.)			
	Mean		7-year mean		Mean		10-year mean		Mean		4-year mean		Mean		7-year mean		Mean		7-year mean		Mean		7-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 69°W.	0.9	S. 52°W.	1.0	N.28°W.	1.0	W.	1.1	S. 64°W.	1.3	S. 57°W.	1.3	N.50°W.	4.4	N.54°W.	3.4	N.52°W.	0.9	N.85°W.	1.1	S. 55°W.	2.7	S. 51°W.	2.2
250	S. 61°W.	1.0	S. 45°W.	1.3					S. 61°W.	1.7	S. 55°W.	1.6					N.41°W.	0.8	S. 69°W.	1.4	S. 50°W.	3.0	S. 50°W.	2.5
500	S. 40°W.	3.3	S. 46°W.	3.2	N.39°W.	1.4	N.87°W.	1.9	S. 55°W.	4.4	S. 62°W.	3.6	N.54°W.	4.9	N.60°W.	3.8	S. 51°W.	0.7	S. 55°W.	2.8	S. 60°W.	6.2	S. 57°W.	5.4
750	S. 50°W.	4.2	S. 50°W.	4.1	N.64°W.	1.8	N.77°W.	3.6	S. 57°W.	6.6	S. 66°W.	5.4	N.53°W.	7.7	N.59°W.	6.0	S. 40°W.	1.0	S. 53°W.	4.0	S. 71°W.	8.4	S. 67°W.	7.1
1,000	S. 63°W.	5.1	S. 64°W.	4.7	N.68°W.	3.3	N.76°W.	4.8	S. 63°W.	8.6	S. 72°W.	7.0	N.49°W.	8.9	N.57°W.	7.2	S. 34°W.	3.7	S. 55°W.	5.4	S. 80°W.	9.7	S. 78°W.	8.2
1,250	S. 72°W.	6.1	S. 76°W.	5.1	N.81°W.	5.4	N.76°W.	5.6	S. 63°W.	11.4	S. 72°W.	8.5	N.53°W.	8.9	N.57°W.	7.8	S. 45°W.	6.0	S. 61°W.	6.5	S. 80°W.	10.8	S. 82°W.	10.0
1,500	S. 71°W.	7.8	S. 79°W.	5.8	N.83°W.	7.3	N.78°W.	7.0	S. 75°W.	12.9	S. 81°W.	9.6	N.53°W.	9.7	N.58°W.	8.9	S. 53°W.	9.3	S. 64°W.	7.5	S. 78°W.	11.8	S. 86°W.	11.0
2,000	S. 70°W.	9.9	S. 81°W.	7.3	N.83°W.	10.6	N.80°W.	9.0	S. 74°W.	14.4	S. 83°W.	10.9	N.54°W.	12.2	N.60°W.	10.3	S. 56°W.	10.5	S. 69°W.	8.6	N.85°W.	13.5	N.88°W.	12.6
2,500	S. 69°W.	11.0	S. 86°W.	9.5	N.78°W.	14.0	N.78°W.	11.5	S. 83°W.	13.7	W.	12.1	N.57°W.	14.9	N.63°W.	12.2	S. 54°W.	12.8	S. 74°W.	9.8	N.85°W.	19.8	N.86°W.	14.2
3,000	S. 71°W.	11.6	S. 88°W.	11.1	N.74°W.	19.0	N.79°W.	13.9	S. 89°W.	15.3	N.87°W.	14.3	N.60°W.	17.1	N.66°W.	13.6	S. 77°W.	13.1	S. 74°W.	11.6	N.81°W.	21.2	S. 88°W.	14.3
3,500	S. 88°W.	13.1	S. 88°W.	12.0	N.70°W.	19.0	N.82°W.	15.4	S. 81°W.	18.8	S. 88°W.	14.7	N.56°W.	16.4	N.72°W.	15.0	N.88°W.	10.2	S. 75°W.	12.0	S. 80°W.	18.2	S. 83°W.	11.9
4,000	N.68°W.	14.3	N.83°W.	11.1	N.83°W.	20.1	N.85°W.	16.8	W.	17.0	N.88°W.	13.2	N.60°W.	13.1	N.74°W.	14.5	N.68°W.	10.0	S. 76°W.	11.4	S. 67°W.	19.1	S. 72°W.	13.7
4,500	N.79°W.	14.8	N.79°W.	12.9	S. 78°W.	20.2	N.74°W.	17.7	W.	18.0	N.88°W.	14.8	N.67°W.	13.0	S. 85°W.	15.0	N.68°W.	9.0	N.88°W.	11.9				
5,000	N.67°W.	18.0	N.81°W.	15.6	S. 77°W.	23.2	N.83°W.	18.6			N.67°W.	12.6	N.68°W.	15.0	N.86°W.	14.8	N.68°W.	11.1	N.82°W.	14.4				